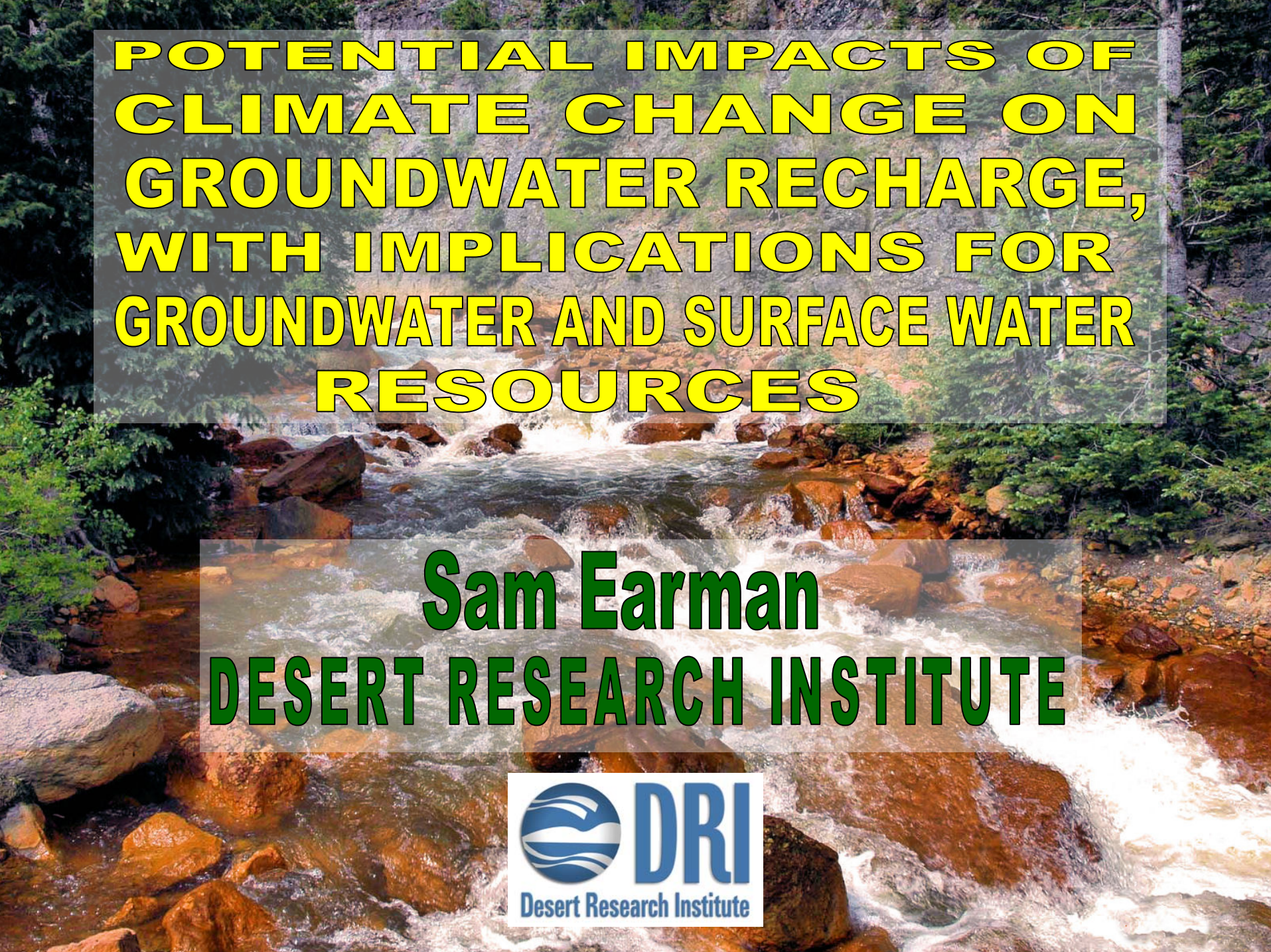

POTENTIAL IMPACTS OF CLIMATE CHANGE ON GROUNDWATER RECHARGE, WITH IMPLICATIONS FOR GROUNDWATER AND SURFACE WATER RESOURCES

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DESERT RESEARCH INSTITUTE

DRI

Desert Research Institute

Acknowledgements

Mike Dettinger

California Energy Commission

US Geological Survey

What is groundwater?

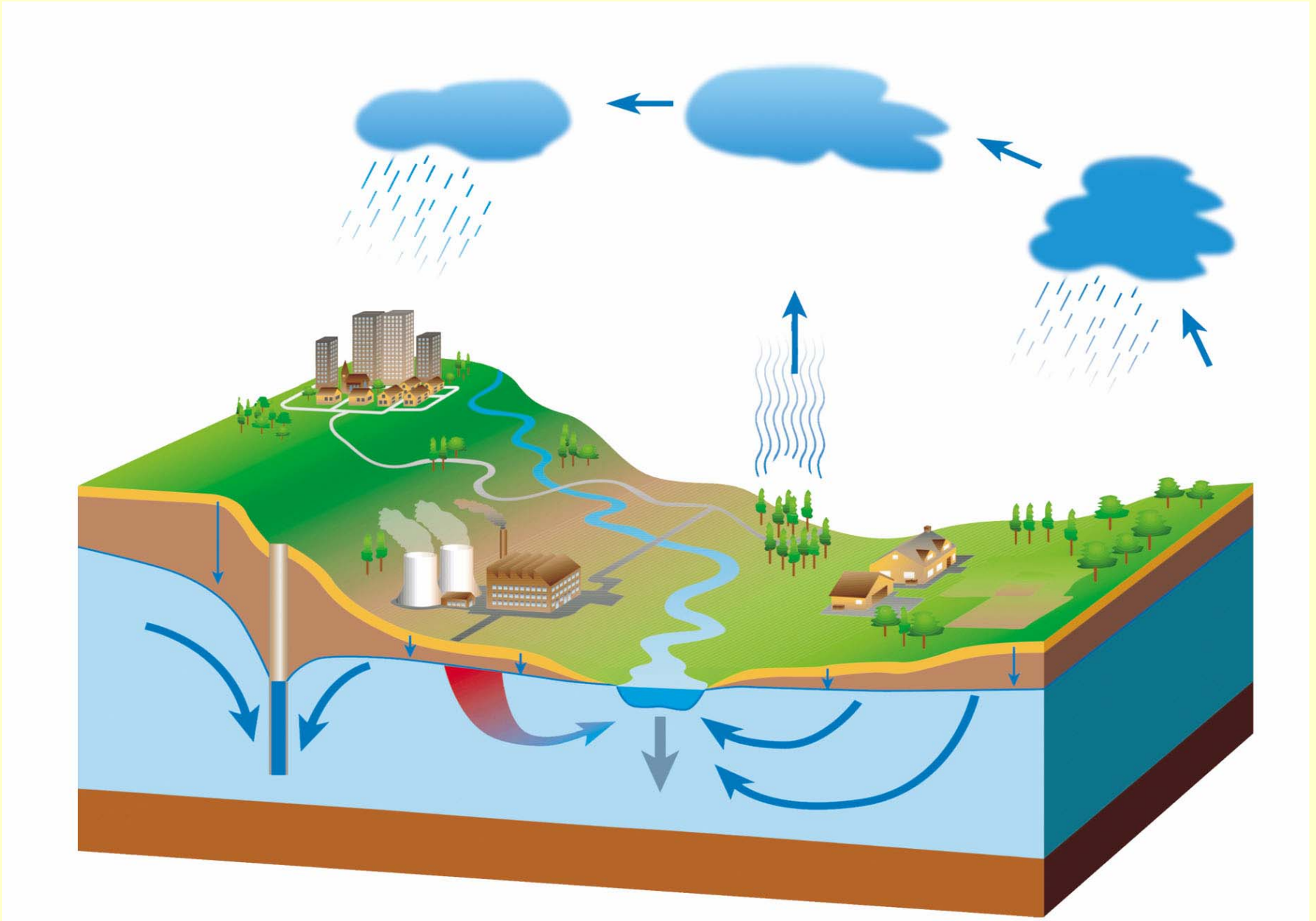
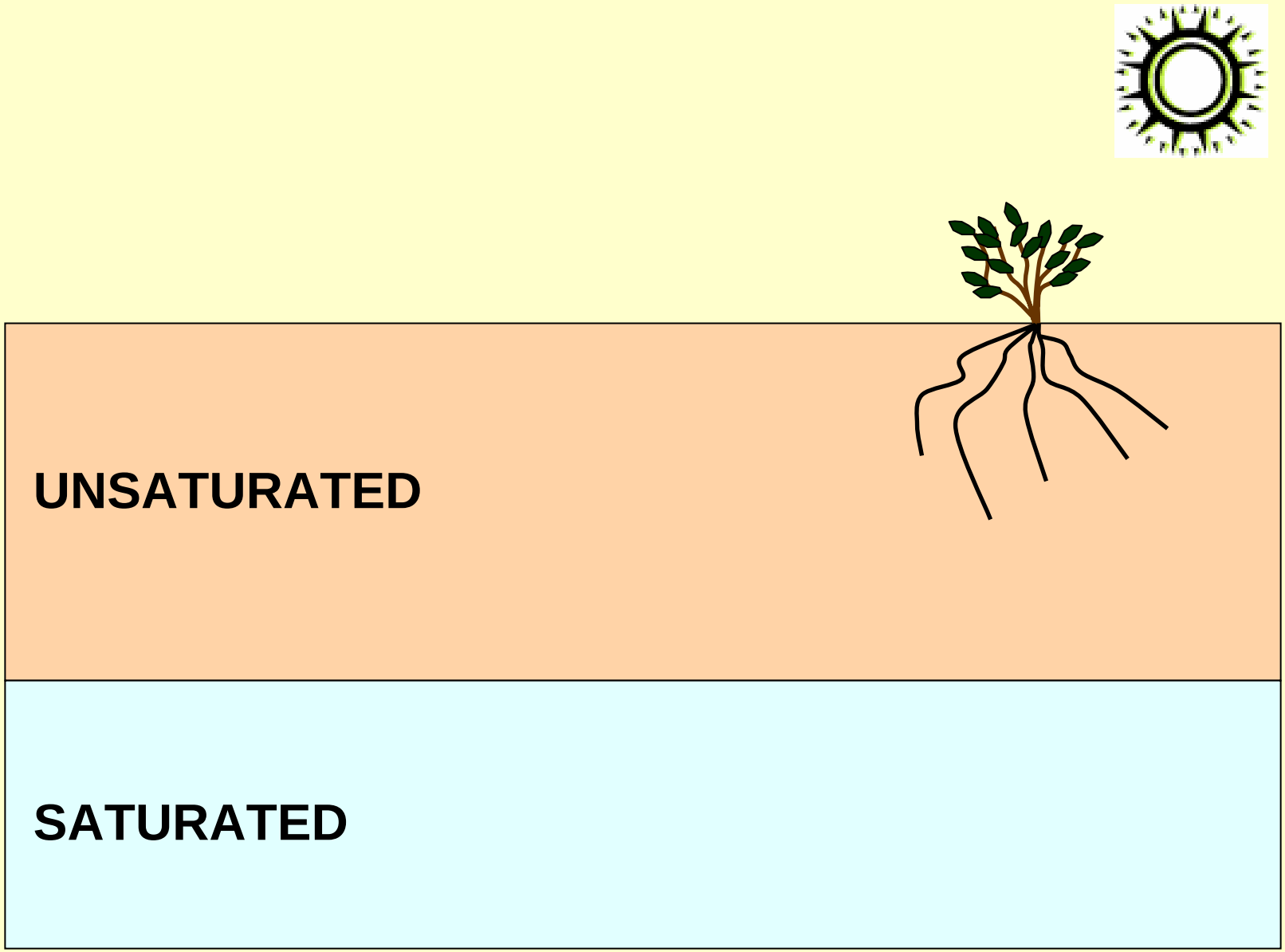


Image from: http://www.eurogeosurveys.org/

Schematic diagram of groundwater recharge



What is groundwater?

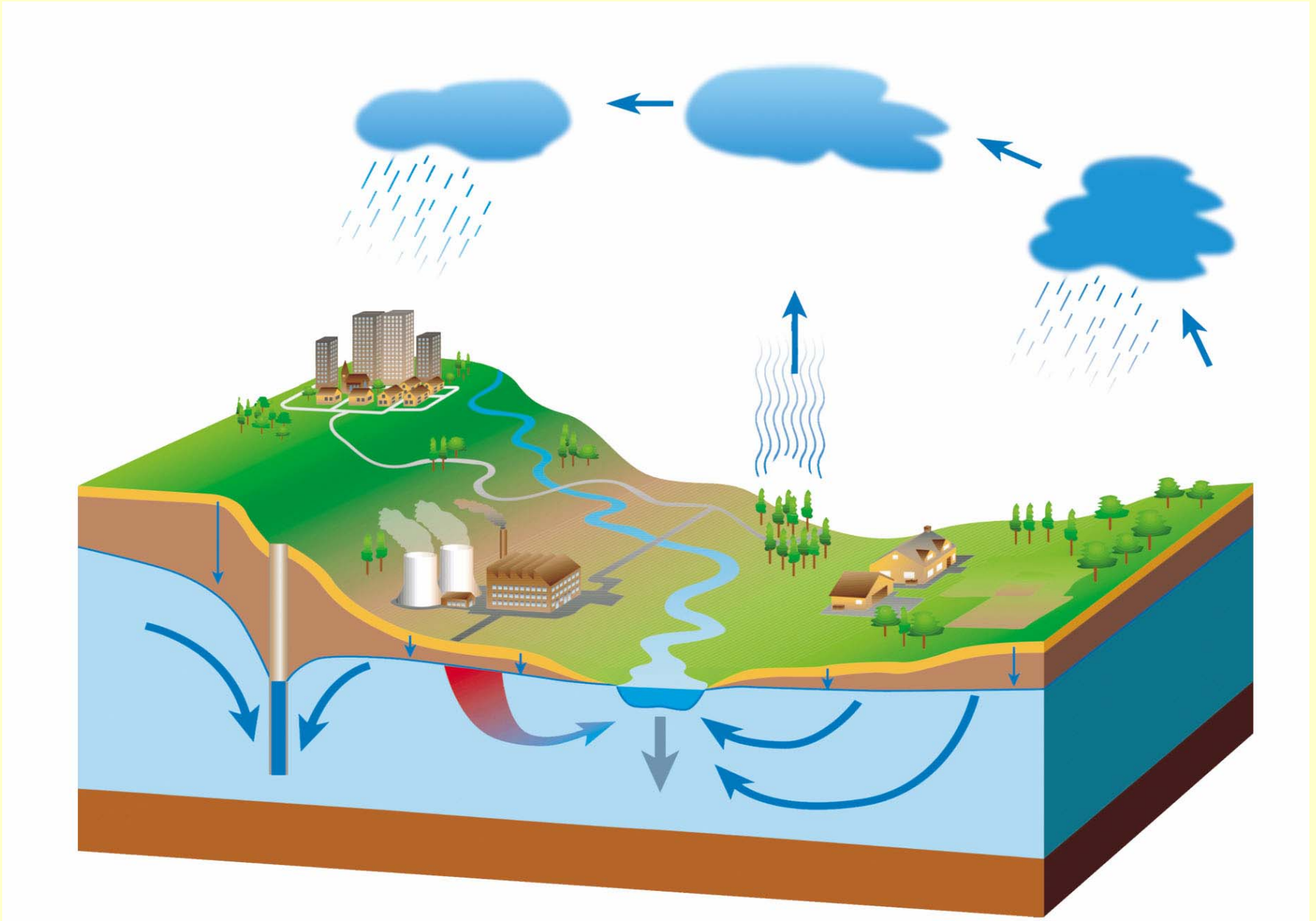
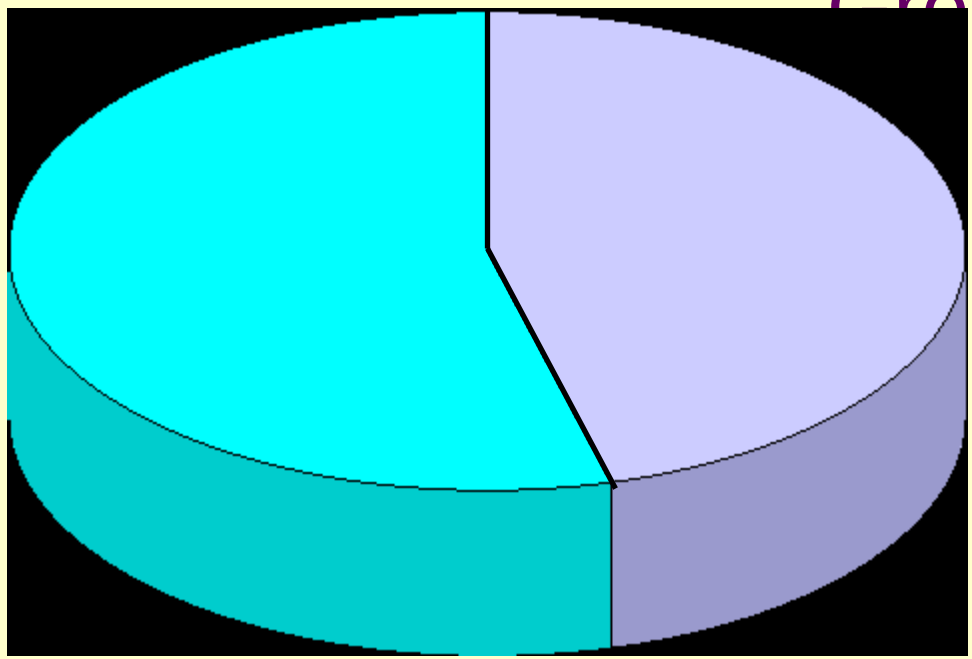


Image from: http://www.eurogeosurveys.org/

Is groundwater an important resource?

Public/municipal water supply in California

Surface water: 52%



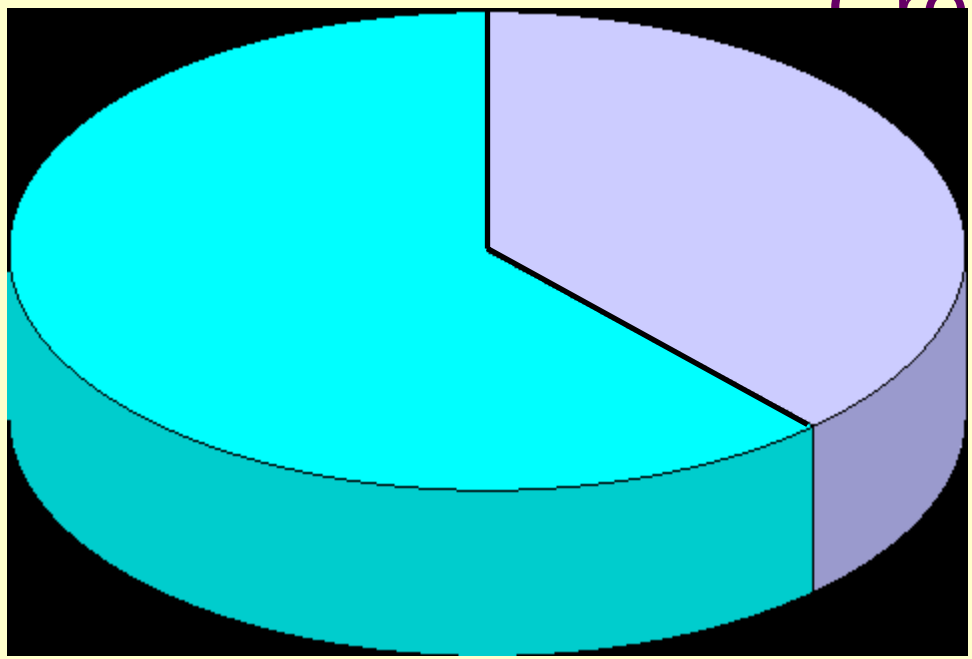
Groundwater: 48%

(calculated from data in Hutson *et alii*, 2004)

Is groundwater an important resource?

Irrigation use in California

Surface water: 62%



Groundwater: 38%

(calculated from data in Hutson *et alii*, 2004)

Groundwater recharge

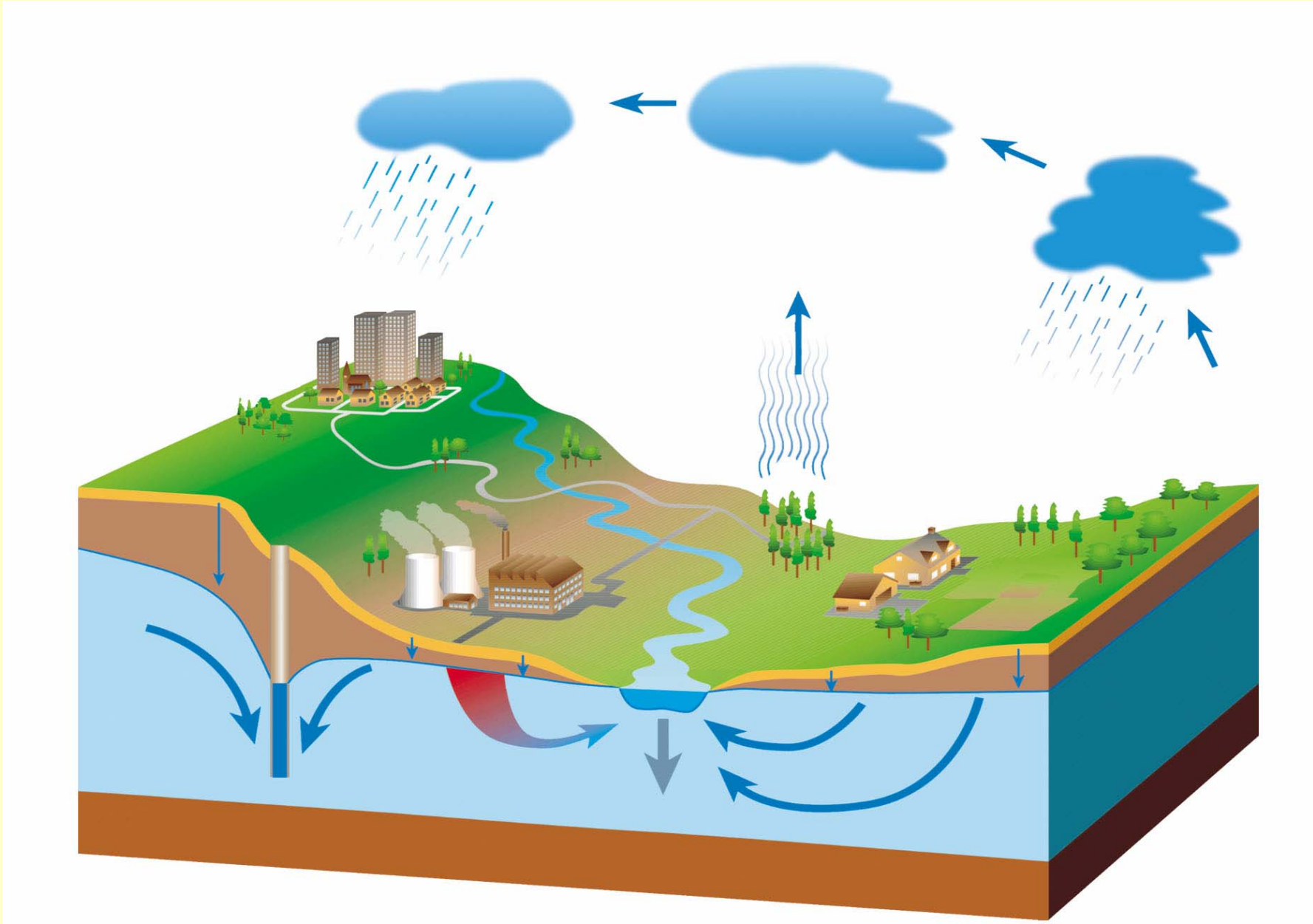
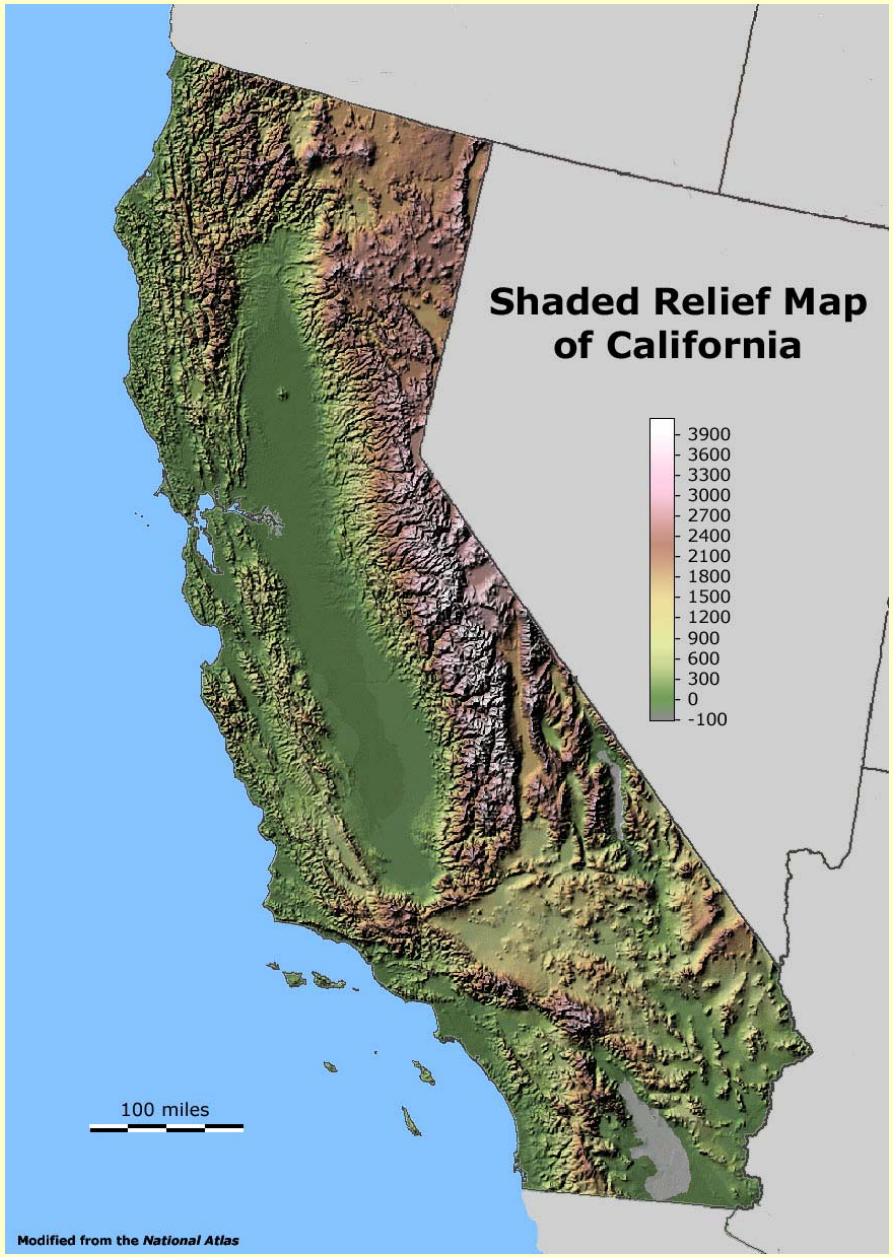
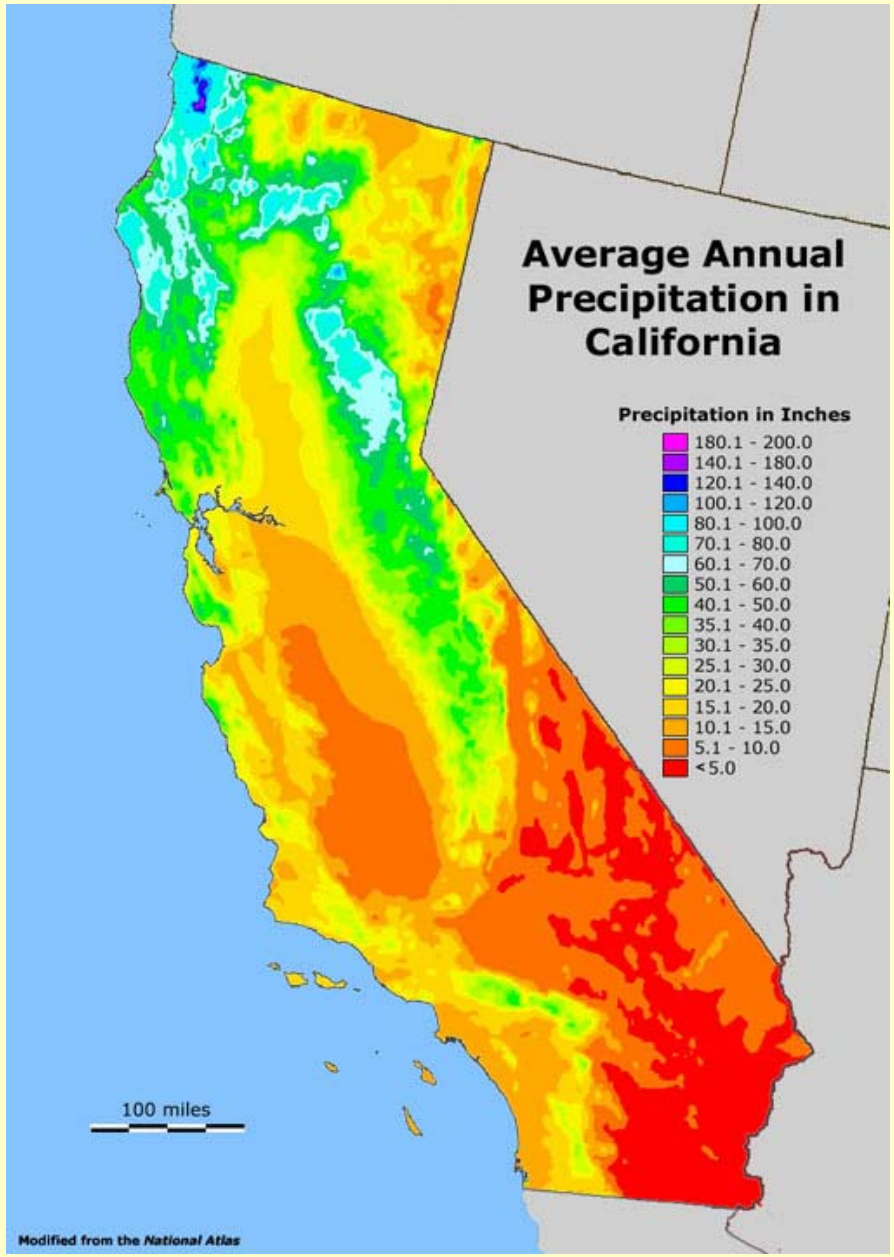


Image from: http://www.eurogeosurveys.org/

Groundwater recharge—precipitation/elevation relationship





Images from: http://education.usgs.gov/california

March 5, 2007 snowpack

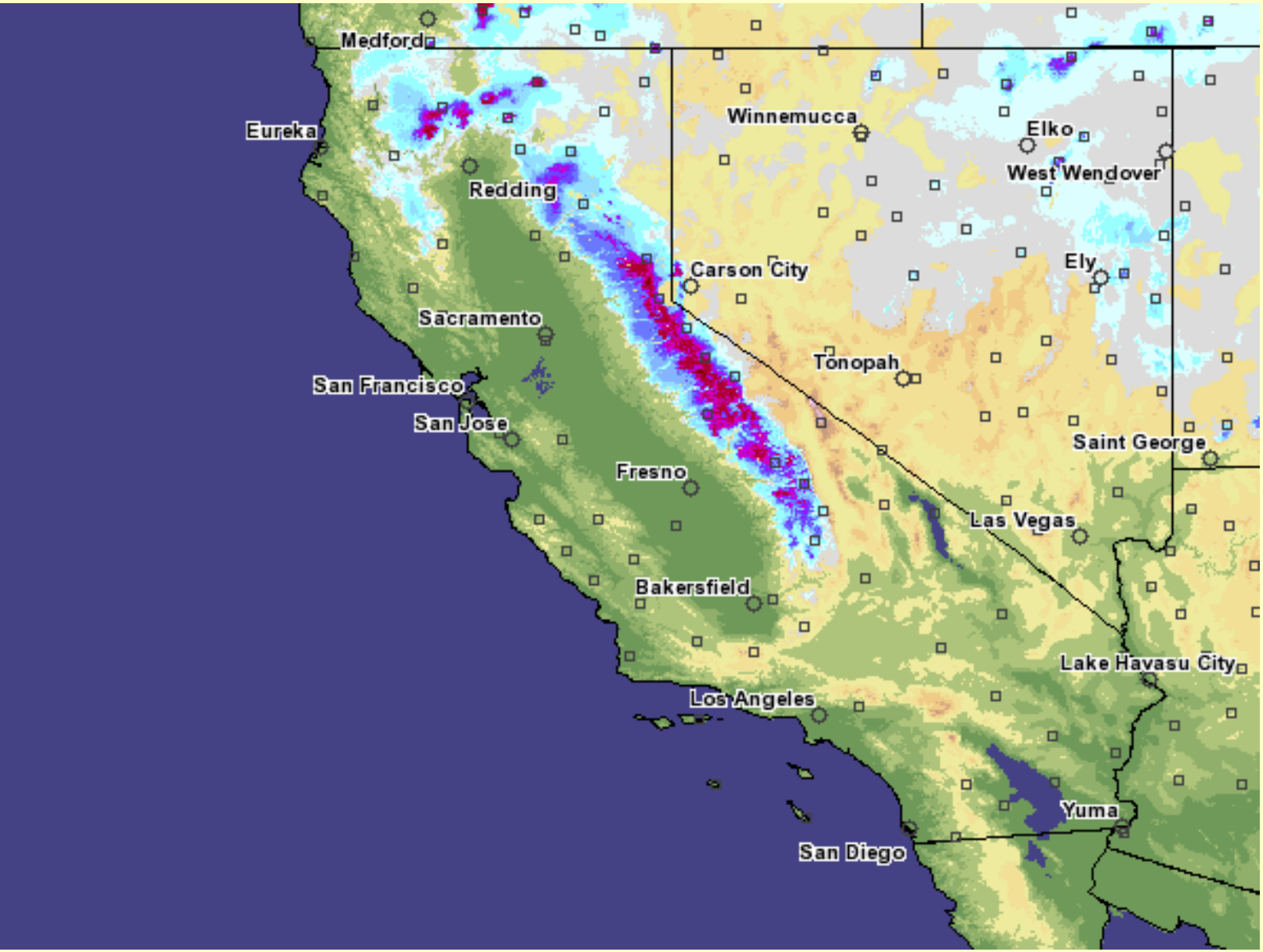
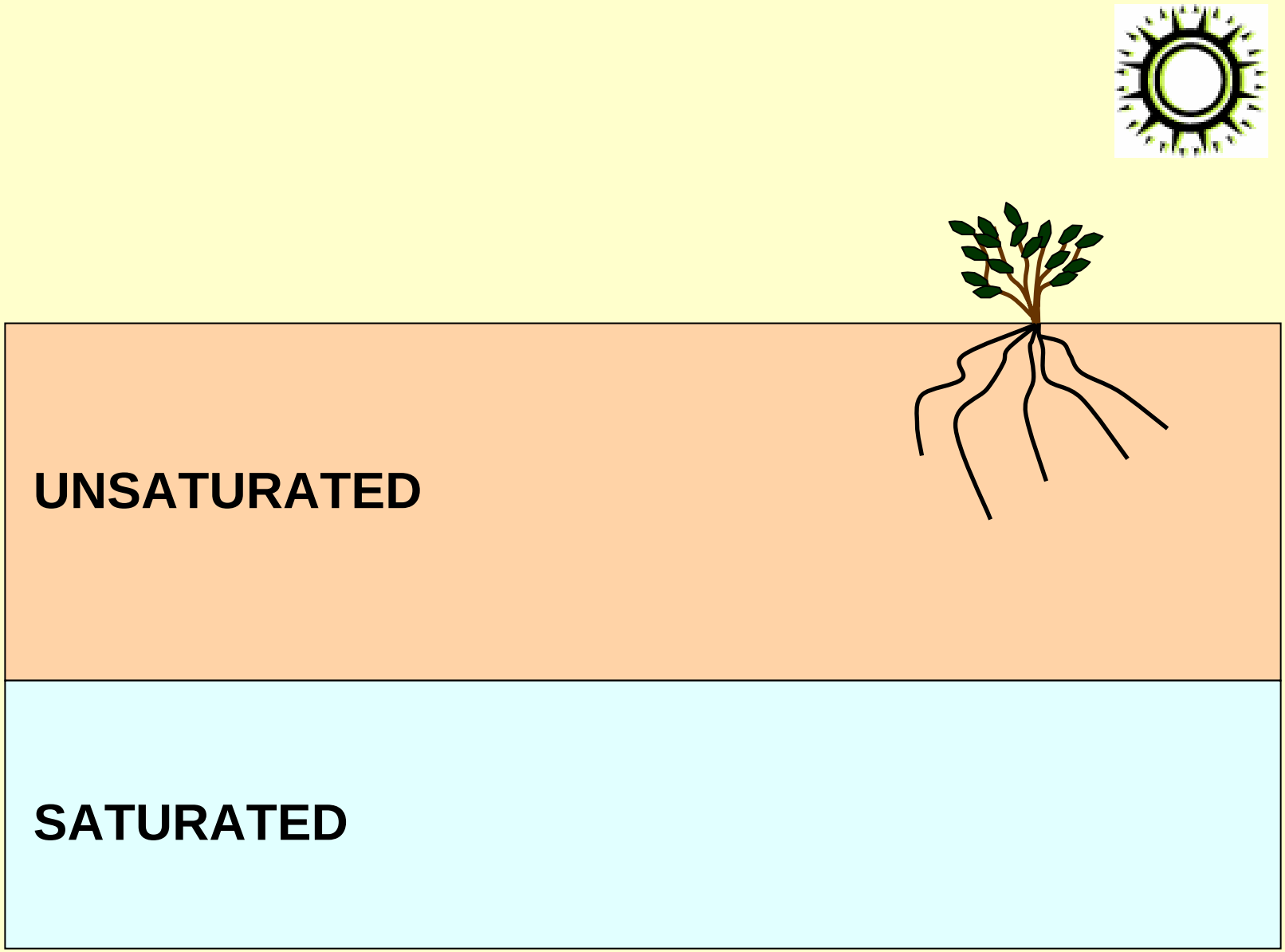


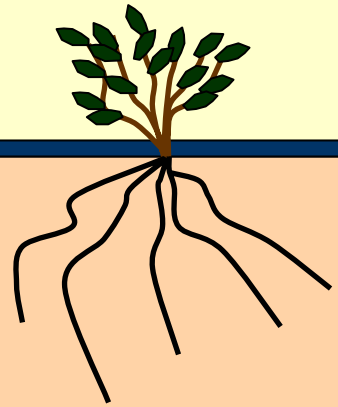
Image from: http://www.nohrsc.nws.gov/

Schematic diagram of groundwater recharge



Schematic diagram of groundwater recharge

Rain: small amount, intermittent

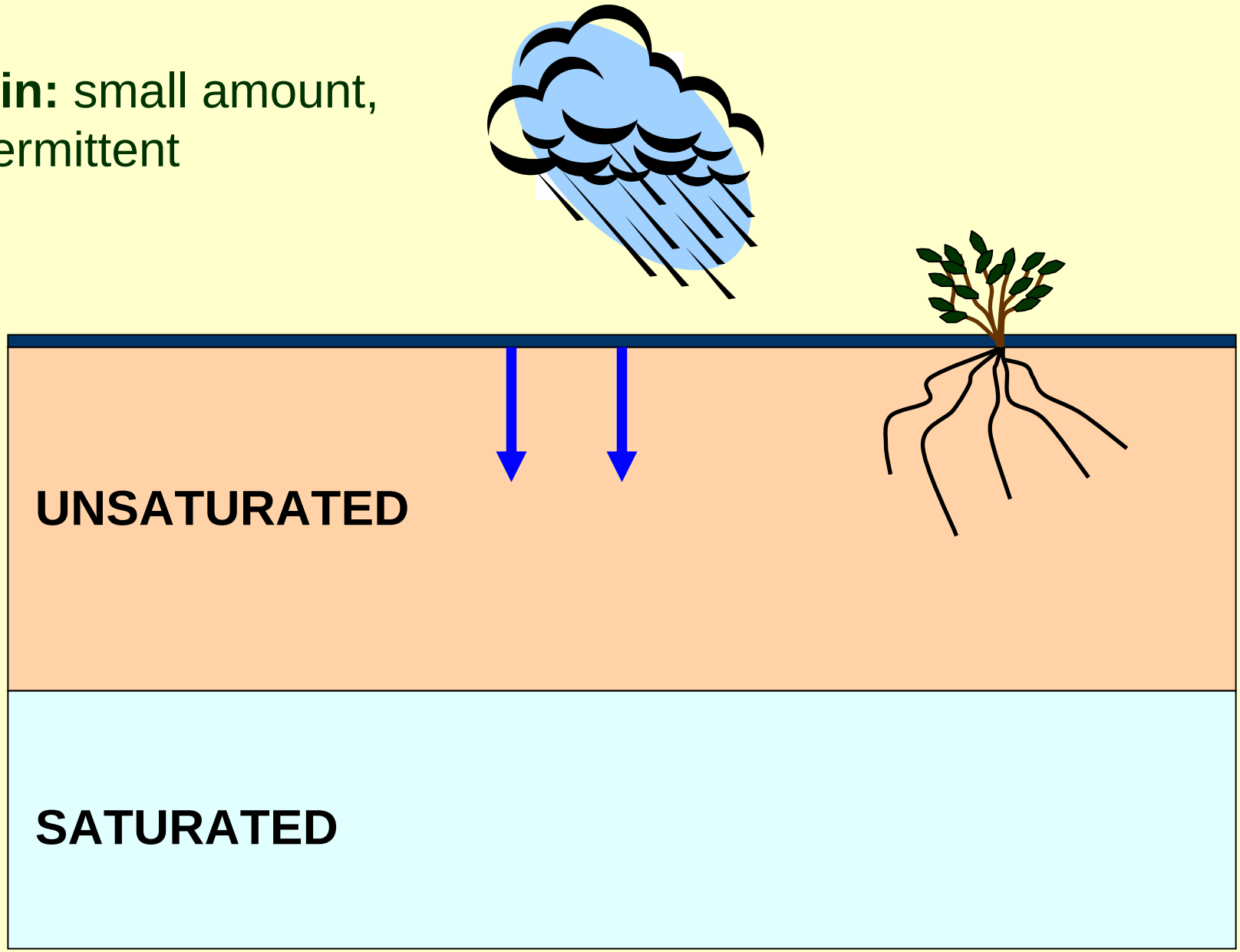


UNSATURATED

SATURATED

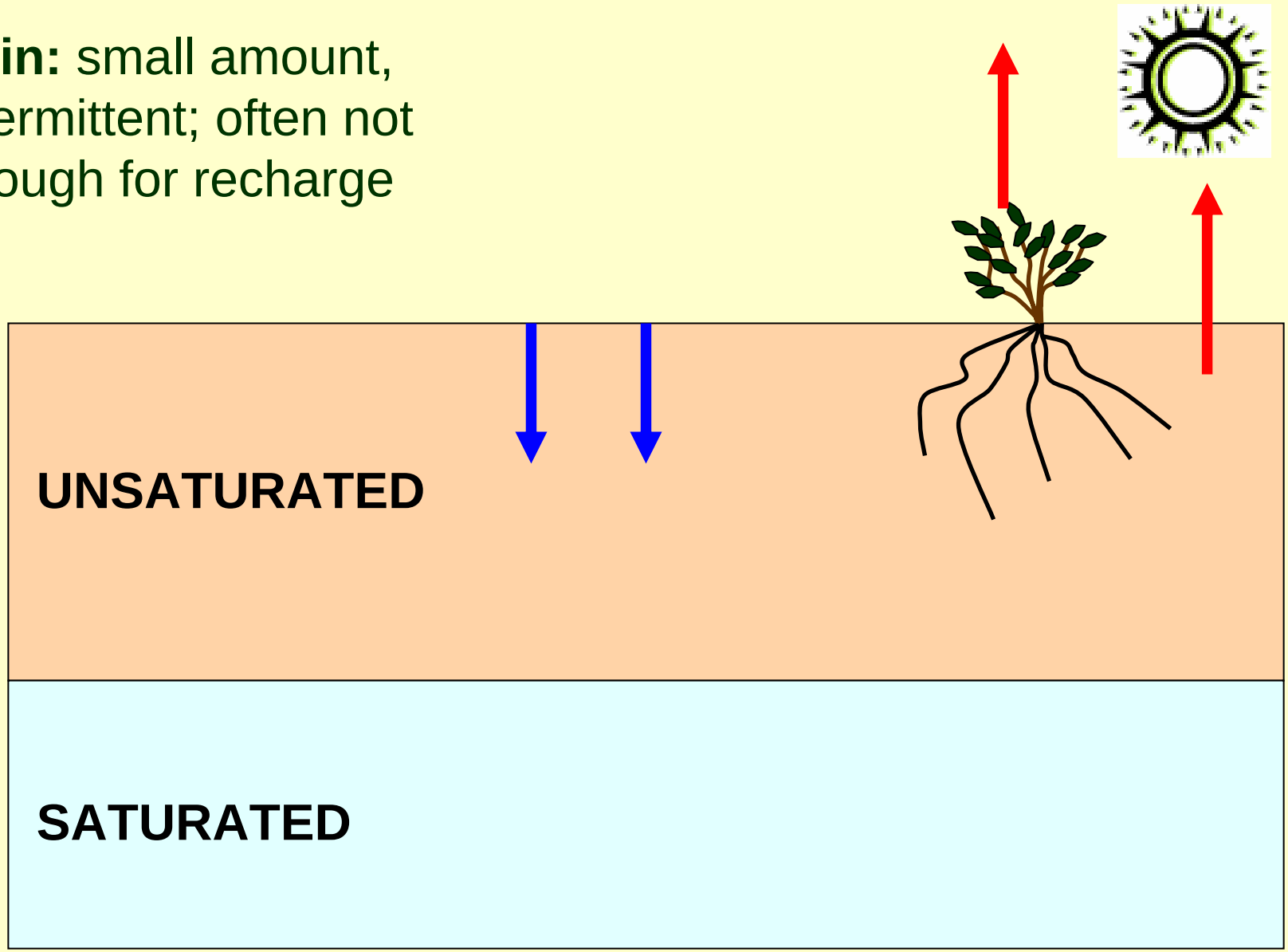
Schematic diagram of groundwater recharge

Rain: small amount, intermittent



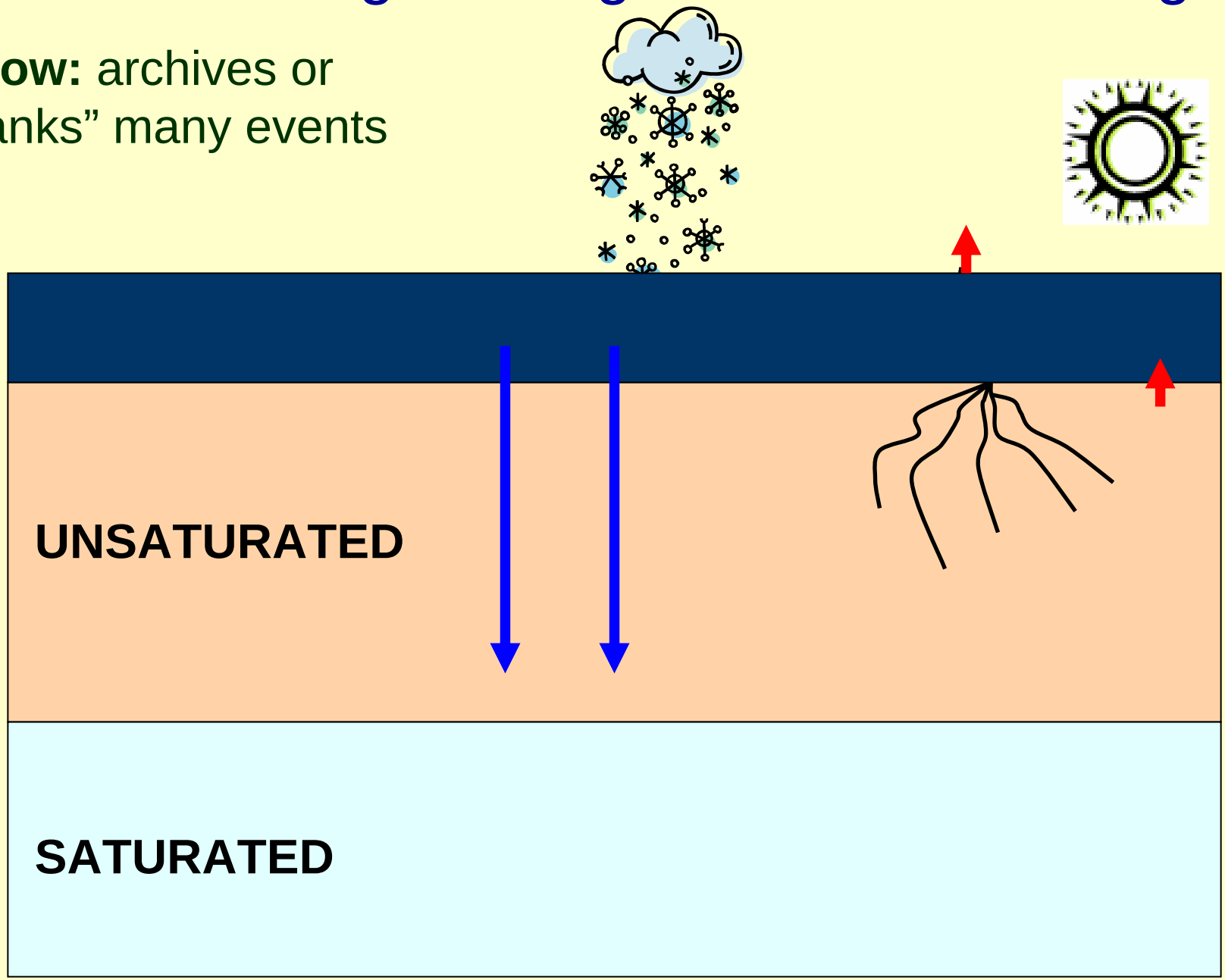
Schematic diagram of groundwater recharge

Rain: small amount, intermittent; often not enough for recharge



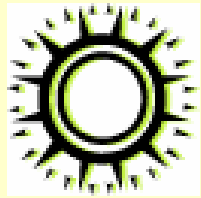
Schematic diagram of groundwater recharge

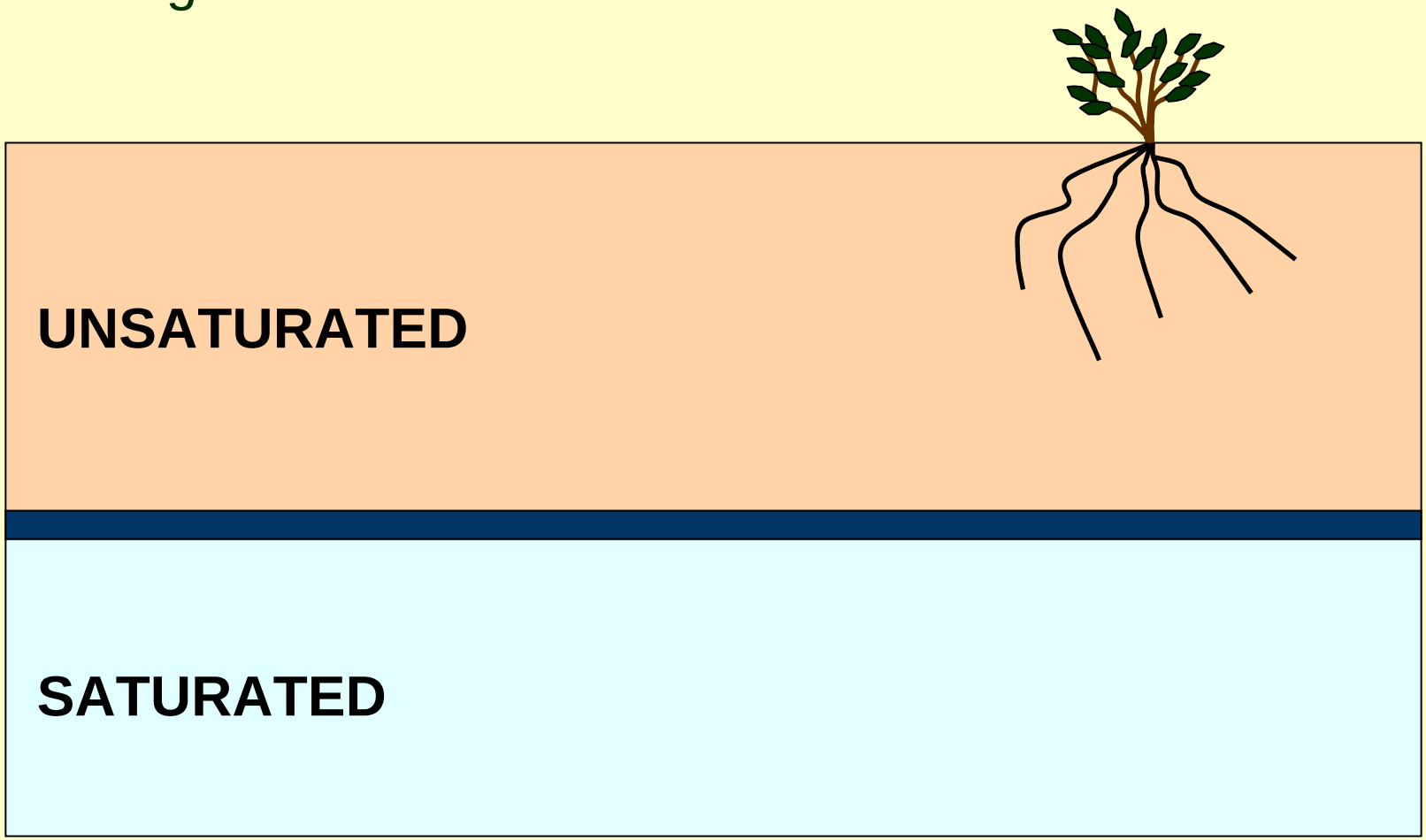
Snow: archives or "banks" many events



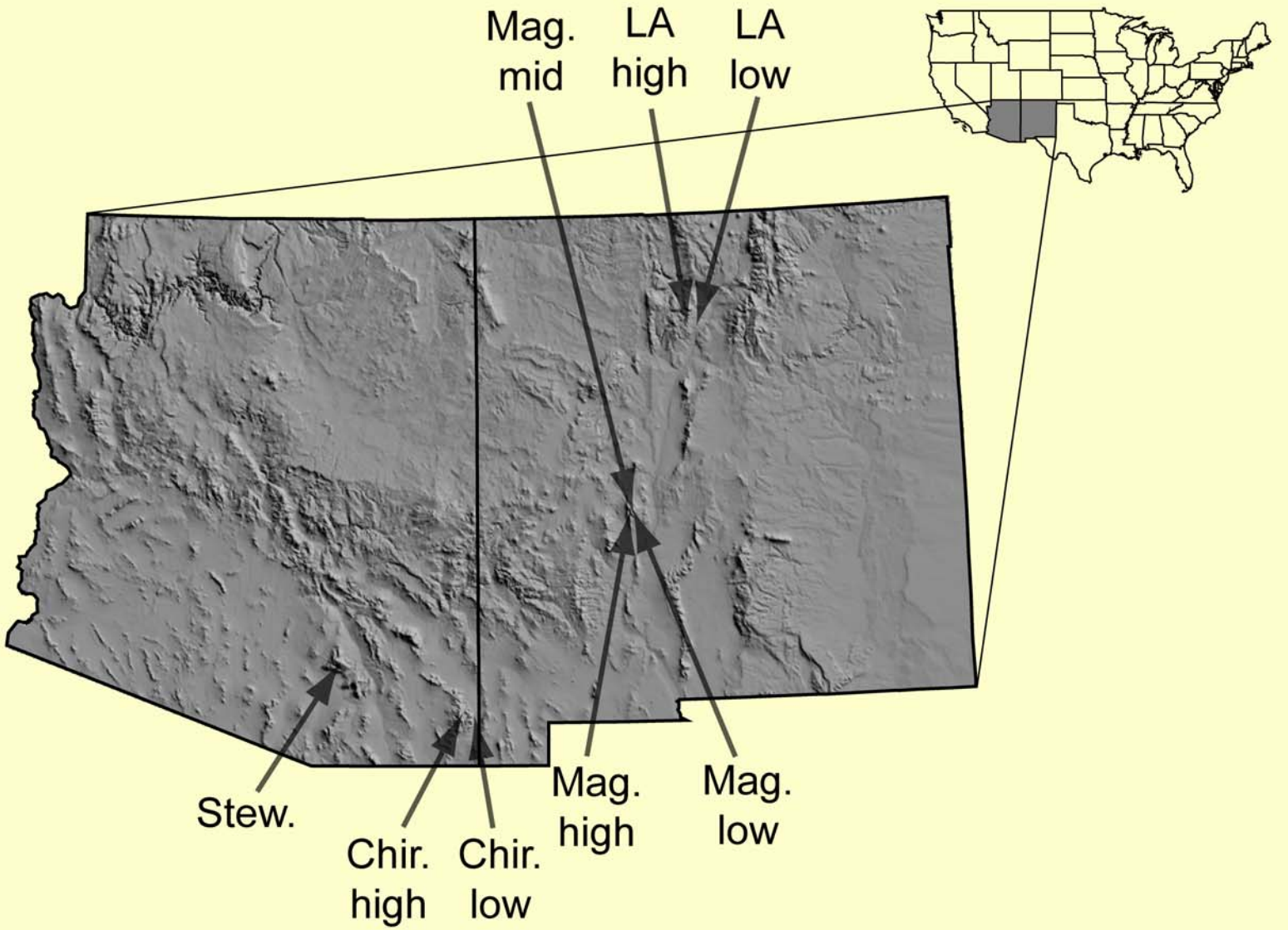
Schematic diagram of groundwater recharge

Snow: archives or "banks" many events; often enough for recharge





Locations of precipitation collectors



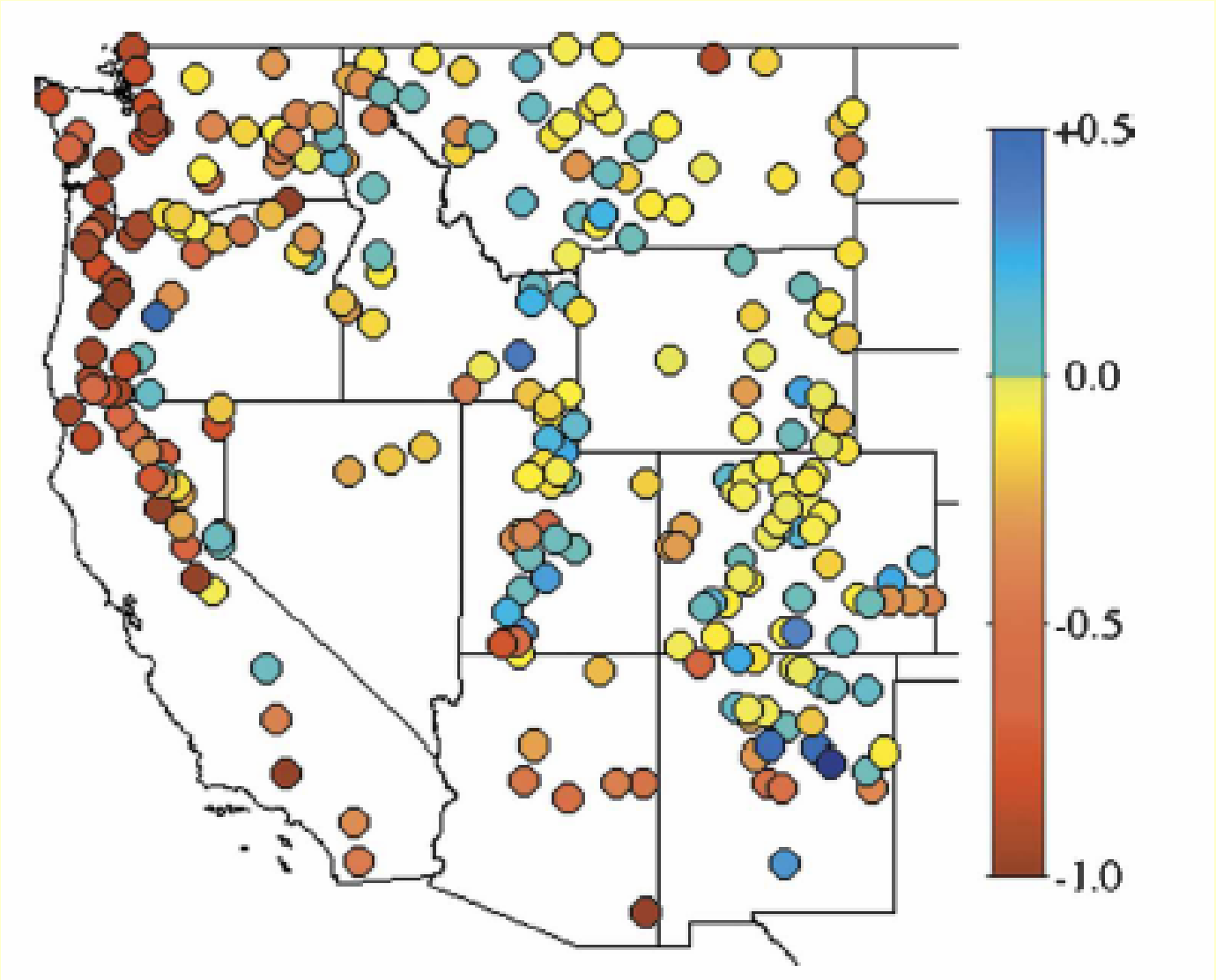
(Earman *et alii*, 2006)

Percentage groundwater recharge from snow

Site	2002-2003	2003-2004	Long-term	Snow Precip %
Chiricahuas	-	-	60	30
Los Alamos	54	48	-	41
Magdalenas	51	69	-	49
Steward	-	43	-	25

(Earman *et alii*, 2006)

Change in winter snowfall water equivalent, 1949-2004



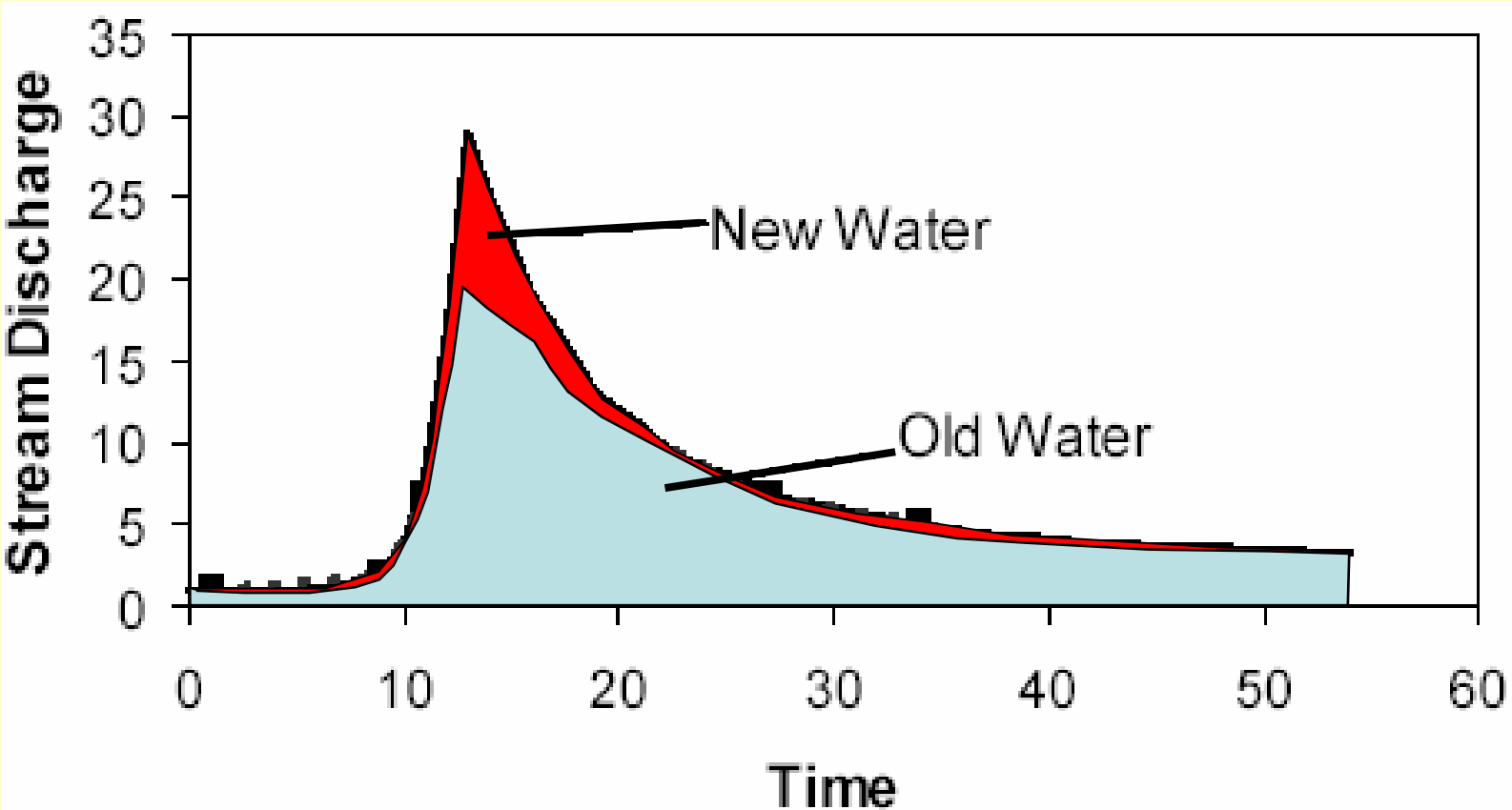
(Knowles *et alii*, 2006)

Climate change-recharge relationship

Snow-to-rain shift could reduce groundwater recharge, even if total precipitation remains constant (or increases slightly)

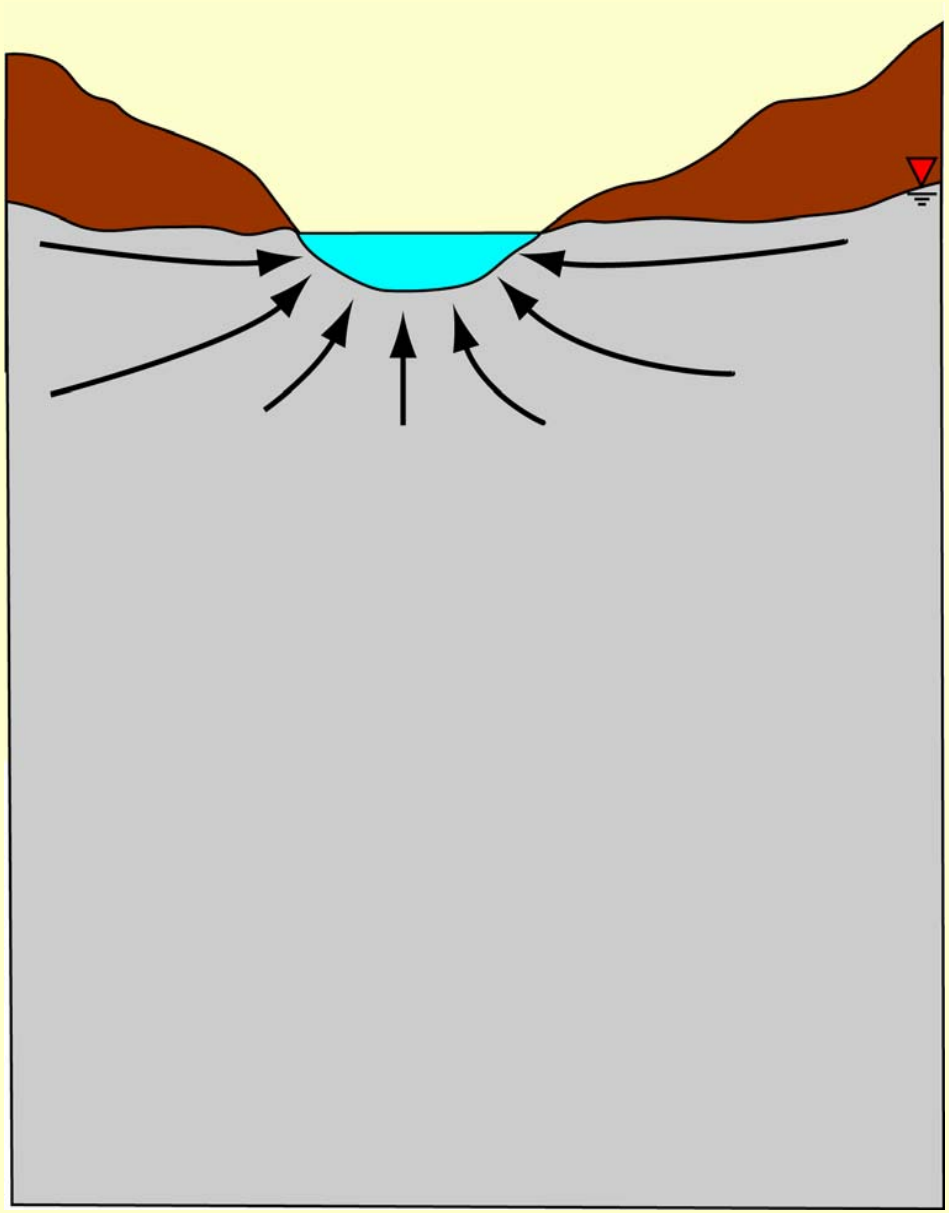
Groundwater input to streams

“New” concept of streamflow



(after McDonnell, 2004)

Aquifer storage/baseflow change ratios



Unsaturated

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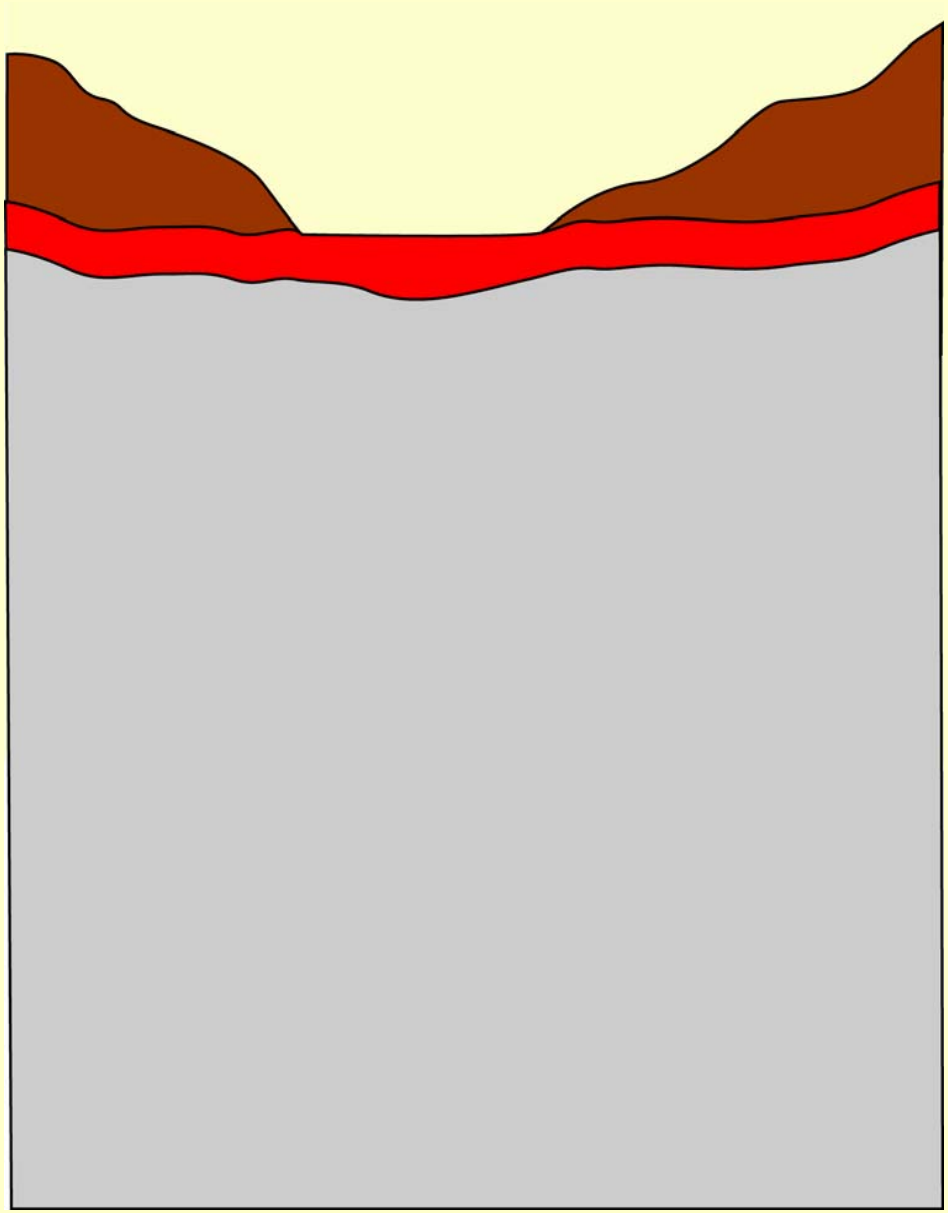
Aquifer storage/baseflow change ratios



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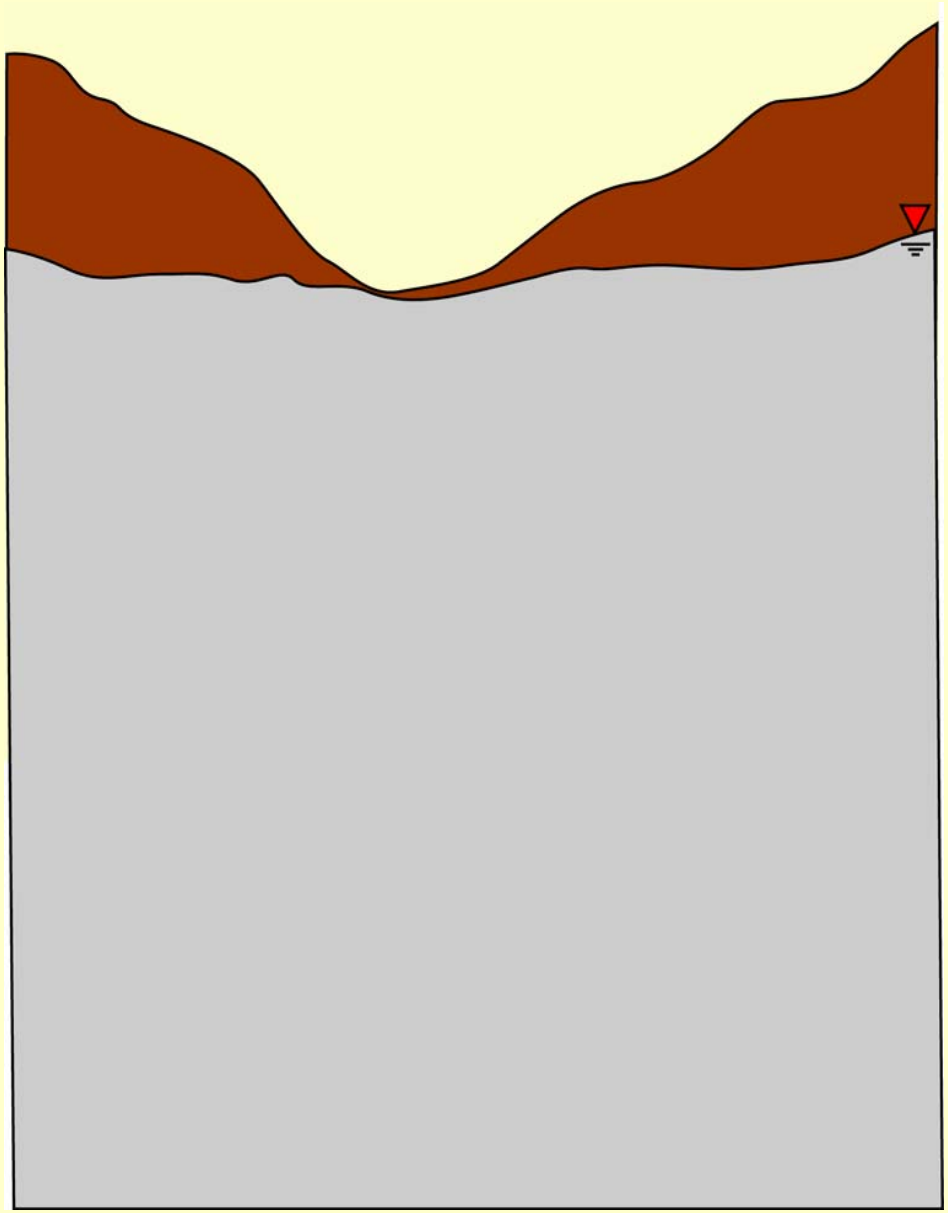
Change in storage

Aquifer storage/baseflow change ratios



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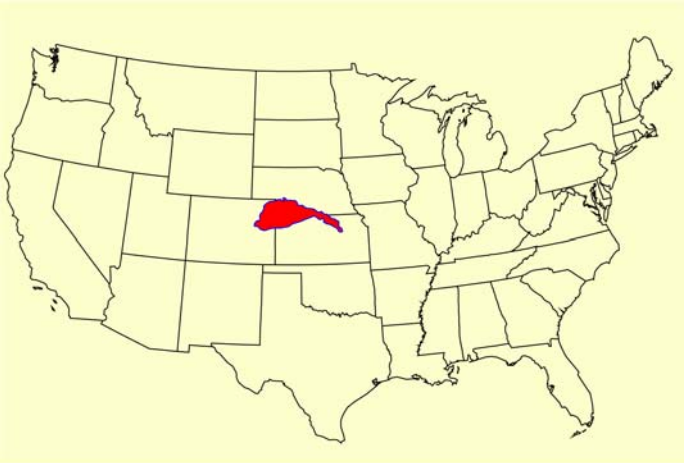
Aquifer storage/baseflow change ratios

Republican River Basin:

3% depletion of groundwater storage led to
50% decline in baseflow



(Data from Alley, 2005)

Conclusions

- Warming could affect groundwater systems
  Snow-rain shift: less recharge?

Conclusions

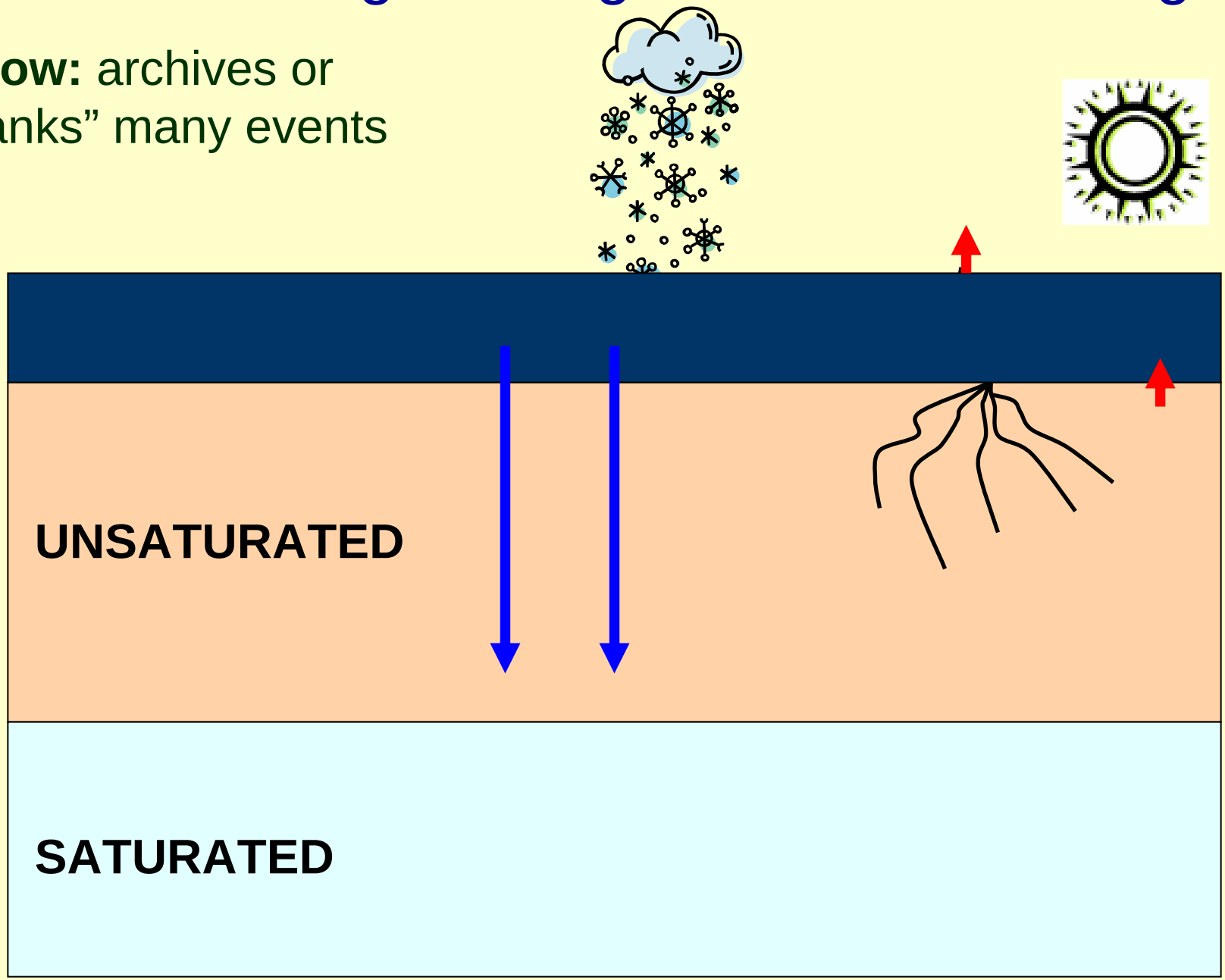
- Warming could affect groundwater systems
  Snow-rain shift: less recharge?
- Small changes in groundwater systems could drive relatively large changes in streamflow

Conclusions

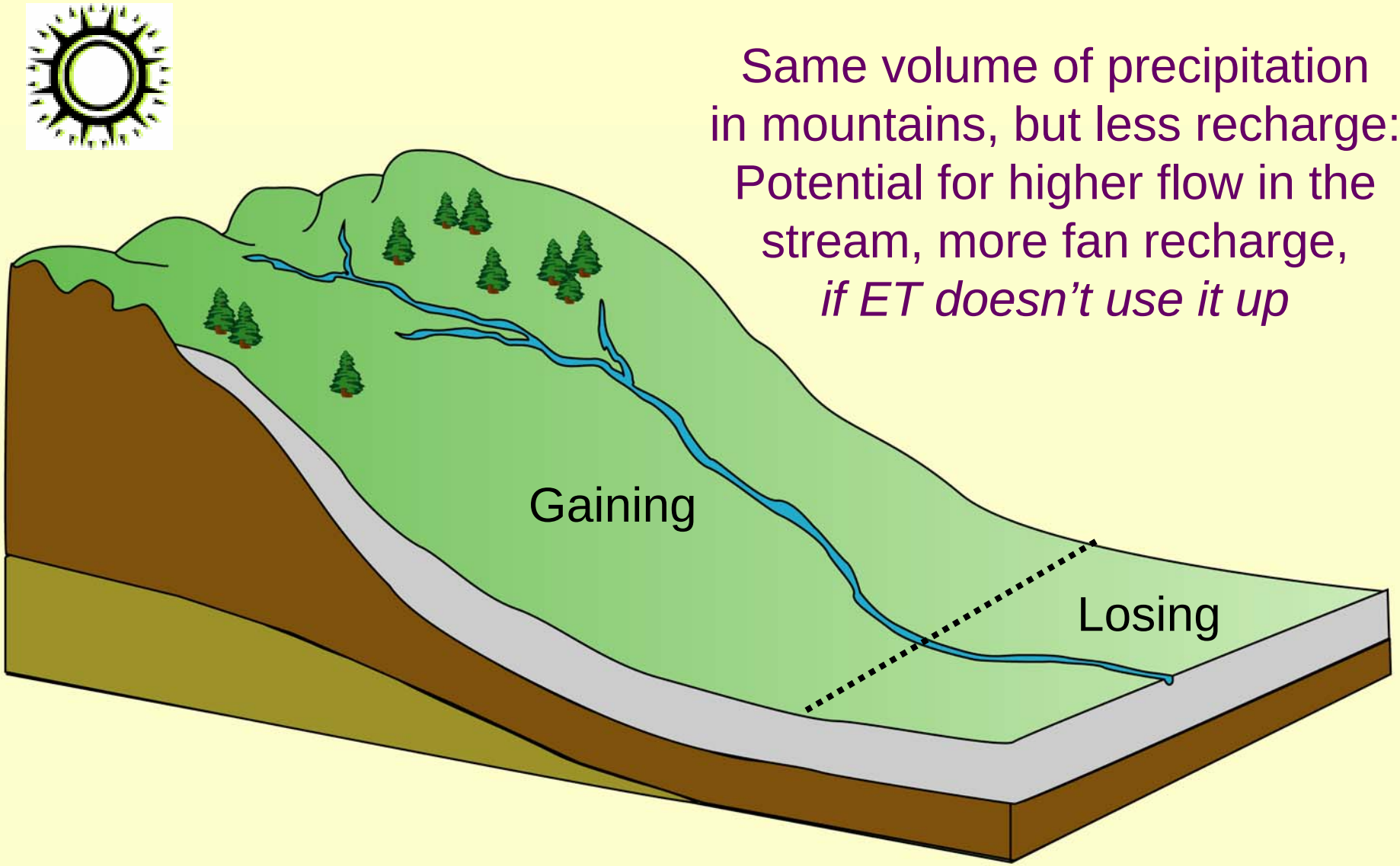
We don’t know enough about how climate could affect water supplies

Schematic diagram of groundwater recharge

Snow: archives or "banks" many events



Could less ‘in-place’ recharge cause more stream recharge?



Same volume of precipitation in mountains, but less recharge: Potential for higher flow in the stream, more fan recharge, *if ET doesn’t use it up*

Conclusions

We don’t know enough about how climate could affect water supplies

Long-term monitoring is needed

Conclusions

We don’t know enough about how climate could affect water supplies

Long-term monitoring is needed

CEC/USGS workshop on long-term monitoring for groundwater systems

Conclusions

CEC/USGS workshop on long-term monitoring for groundwater systems:

Potential exists to establish a viable long-term multi-technique observation network, **but prior work/learning mode is needed given the state of the science**

-no mountain experience with some methods
-no experience with repeated observations with other methods
-no experience integrating interpretation